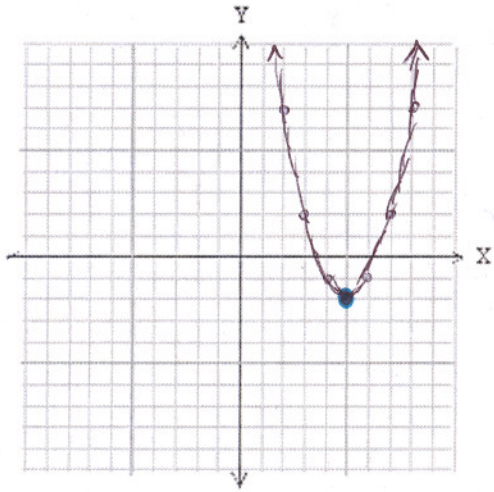


A vertex is always the highest or lowest point of a quadratic function.

If the parabola opens UP (which means a is positive +),



the vertex (h, k) is the lowest point

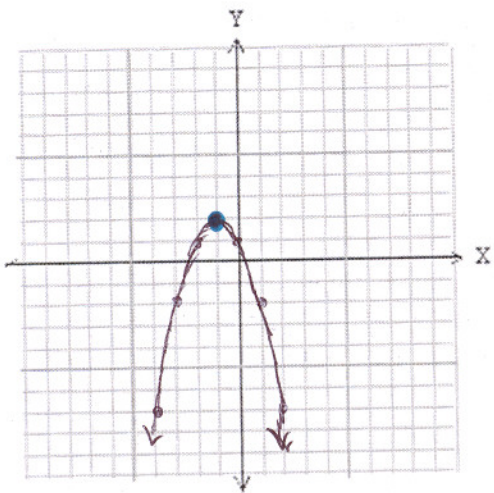
and k is the MINIMUM value of the function.

---

← The vertex is (5, -2), so the minimum value is -2.

---

If the parabola opens DOWN (which means a is negative -),



the vertex (h, k) is the highest point

and k is the MAXIMUM value of the function

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← The vertex is (-1, 2), so the maximum value is 2.

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Ex: Find the maximum or minimum value of this function:

$$f(x) = 4x^2 + 8x - 1$$

Step 1 - Put in vertex form  $y - k = a(x - h)^2$

$$y = 4x^2 + 8x - 1$$

$$y + 1 = 4x^2 + 8x$$

$$y + 1 = 4(x^2 + 2x)$$

$$y + 1 + 4 = 4(x^2 + 2x + 1)$$

$$y + 5 = 4(x + 1)^2$$

Step 2 - Identify vertex

$$y + 5 = 4(x + 1)^2$$

$$\boxed{\text{vertex: } (-1, -5)}$$

$\quad \quad \quad h \quad k$

Step 3 -  $k$  is either a maximum or minimum. Look at  $a$  to determine which one.

$$y + 5 = 4(x + 1)^2$$

$a$  is positive, so graph opens UP



vertex must be minimum

minimum value is -5